able to satisfactorily locate customers and engineer the appropriate network under all circumstances.

Even after standardizing a number of key inputs, the results of BCPM3.0 and HM5.0 are still far apart. For example, after standardizing structure sharing assumptions, there is still a significant difference in loop investment between the two models. This is due to differences in both input prices, which have not been standardized in this analysis, basic loop engineering, and customer location methods. Thus, it appears that there has not been much, if any, convergence between the models on this fundamental issue.

Finally, it must be kept in mind that proxy models are not likely to accurately estimate the forward-looking cost levels of an efficient actual market participant. First, as we noted in Section I, the scorched node approach used by the proxy models produces the costs of a hypothetical market participant and is not likely to accurately reflect the forward-looking costs of an actual market participant. Second, given this qualification, proxy models are inherently limited in their ability to determine optimal solutions because of their general nature and their reliance on publicly available data. This is a limitation of all proxy models and not a shortfall of any particular model. Given this inherent limitation, proxy models are not suited to accurately reflect the forward-looking costs of actual market participants. The most that should be asked of proxy models is to reflect relative cost relationships for the purpose of identifying high-cost areas. However, even in this regard, the models are still in need of improvement.

# Engineering Evaluation of Cost Proxy Models

# For Determining Universal Service Support:

# Hatfield Model Version 5.0,

# Benchmark Cost Proxy Model Version 3.0

# And Hybrid Cost Proxy Model 2.0

ComPlus

Principal Investigator:

Robert F. Austin, Ph.D.

January 14, 1998

## Executive Summary

Under the authorization of the United States Telephone Association ("USTA"), the principal investigator has reviewed various cost proxy models and model components during the past thirteen months. During this period of model definition and refinement, there has been some noticeable convergence of the algorithms and structures of the models, but little convergence of the user interfaces. The operation of the models has stabilized significantly, although performance has suffered dramatically as each model has incorporated additional procedures, interfaces, reports and data for the sake of thoroughness. The models still reveal their divergent underlying assumptions in the results generated by users, although the gaps in results are smaller than in the past.

Brought into stark relief in part by the convergence of the algorithms, the fundamental problem of data input remains a matter of serious concern. The specification of input parameters is a major issue that must be addressed during the months ahead as model building proceeds. We discuss the direction in which these efforts should proceed.

## Contents

**Engineering Evaluation of Cost Proxy Models For Determining Universal Service Support: Hatfield Model Version 5.0, Benchmark Cost Proxy Model Version 3.0 And Hybrid Cost Proxy Model 2.0**

**ComPlus**

**Principal Investigator:**
**Robert F. Austin, Ph.D.**

**January 14, 1998**

## Introduction

Under the authorization of the United States Telephone Association ("USTA"), the principal investigator has reviewed various cost proxy models and model components during the past thirteen months. We have provided engineering evaluations of all or part of several versions of models submitted in connection with the Federal Communication Commission's ("FCC") Universal Service proceeding, CC Docket 96-45 and the related CC Docket 97-160. Our evaluations have included formal reports on:

- The Hatfield Model, sponsored by AT&T and MCI ("Hatfield Model"), Version 2.2, Release 2.[1]
- The Benchmark Cost Proxy Model, sponsored by Sprint, US West and Pacific

[1] Robert F. Austin, Ph.D. *Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model 2.2, Release 2, Ex Parte* Filing, Federal Communications Commission Docket No. 96-45, February 5, 1997.

Bell ("BCPM"), Version 1.0.[2]

- The Hatfield Model, Version 3.0, reviewed concurrently with Version 3.1.[3]

During subsequent months, our evaluations included the analysis and review of user-input values and other parameters and values for these models. Our efforts also included reviews and unpublished analyses of the Hatfield Model, Version 4.0 and revised components of the BCPM. Finally we performed a detailed evaluation of certain key modules of the Federal Communications Commissions Hybrid Cost Proxy Model, Version 1.0.[4]

The present study constitutes a review and synthesis of our findings regarding the latest iterations of three models:

- The Hatfield Model, Release 5.0, sponsored by AT&T and MCI, released December 15, 1997 and referred to by its developers as "HM 5.0."
- The Benchmark Cost Proxy Model, sponsored by BellSouth, Sprint and US West, released on December 11, 1967 and referred to by its developers as "BCPM 3.0."
- The Hybrid Cost Proxy Model, sponsored by the Federal Communications Commission, released on December 17, 1997 and referred to by its developers as "HCPM 2.0."

Sponsors have made numerous representations regarding the convergence of these models in multiple venues during the past thirteen months of testing and public

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[2] Robert F. Austin, Ph.D. *Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Benchmark Cost Proxy Model*, *Ex Parte* Filing, Federal Communications Commission Docket No. 96-45, February 23, 1997.

[3] Robert F. Austin, Ph.D. *Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model 3.0/3.1*, *Ex Parte* Filing, Federal Communications Commission Docket No. 96-45, March 17, 1997.

[4] Robert F. Austin, Ph.D. *Comment on the Hybrid Cost Proxy Model for Determining Universal Service Support for Non-Rural Carriers: The CENBLOCK and FEEDDIST Software Modules*, *Ex Parte* Filing, Federal Communications Commission Docket Nos. 96-45 and 97-160, December 3, 1997.

evaluation.[5] This is due in no small way to the encouragement of the Common Carrier Bureau of the FCC, which has conducted numerous weekly meetings and hearings and which has provided substantial guidance to the developers of the models.[6] Indeed, we acknowledge several examples of convergence in structure that have resulted in some convergence of the output from these models.

It is our opinion, however, that these instances of convergence are of relatively minor significance to the overall model building process. In fact, we believe these examples, which appear primarily to be concessions to physical appearance, actually may be serving to mask fundamental differences that continue to preclude the attainment of the FCC's goals.

The FCC and the sponsors and authors of the models under review have acknowledged the benefits of distinguishing between the algorithms that constitute the models' platforms and the user input and otherwise defined data analyzed using those platforms. The present round of model evaluations focuses on the model platforms. It is understandable, then, that although numerous changes have been made in the platforms, with few exceptions only minor adjustments have been made to the user-input data provided by the developers and sponsors.

Due to the interrelated nature of the variables, this continuing problem with data precludes some types of evaluation, including an assessment of plausibility. Our earlier reports identified several issues associated with the development of each model and

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[5] See, for example, *Joint Comments of BellSouth Corporation, BellSouth Telecommunications, Inc., US West, Inc., and Sprint Local Telephone Companies to Further Notice of Proposed Rulemaking Sections III.C.5, 7, 8 and III.D Platform, III.B.3 & III.C All Inputs and IV and V*, October 17, 1997, section II, page 2.

[6] Federal Communications Commission, *Further Notice of Proposed Rulemaking*, FCC 97-256, Released July 18, 1997, paragraph 34, page 18 and Federal Communications Commission Public Notice, *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, DA 97-2372, Released November 13, 1997, page 2.

version in this regard, information that is not repeated in its entirety here. However, because of the continuing nature of the problem, excerpts from those earlier reports are included to highlight certain issues.

An evaluation of the fundamental differences that remain in the models cannot proceed without some consideration of the basic values used for analysis. We believe that four key areas of concern can be identified:

- Methods of defining locations
- Structure sharing
- Input prices and related input values
- Loop engineering assumptions

We will focus on these four areas of concern in our summary analysis.

## Evaluation Methodology

### *Test Hardware Configuration*

All testing was performed using the same computing hardware platform:

- IBM ThinkPad 765
- Pentium processor operating at 166 megahertz
- 32 megabytes of memory
- 3 gigabytes of total storage, partitioned with 800 megabytes free on the C: partition (2 gigabytes total) and 500 megabytes free on the D: partition (1 gigabyte total), 1.2 gigabytes free space
- 12X CD ROM
- 13.1 inch screen

The system was running Windows 95 with all appropriate operating system (OS) patches and Service Releases (SR). The system was running the complete Microsoft Office 97 office suite, Professional Edition, including Microsoft Excel 97 and Microsoft Access 97, with all SR-1 patches. The system contained a complete installation of Microsoft Visual Basic 5.0 Professional Edition. As described in the appropriate sections, a complete reinstallation was performed to accommodate the models.

### *Data Sample*

To simplify testing, the five states that the FCC specified in the November 13, 1997 Public Notice were selected for review.[7] These states were Florida, Georgia, Maryland, Missouri and Montana. It is our opinion that the results of analysis of these five states provide a reasonable reflection of the overall performance of the models. Moreover, it is our opinion that these states constitute a reasonable abstraction of

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[7] Federal Communications Commission Public Notice, *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, DA 97-2372, Released Novem-

national network construction and operating conditions. Consequently, the submission by the sponsors of the models of additional data does not, in our opinion, require additional testing at this time.

The results of our analysis were essentially identical to the results reported by Christensen Associates in that firm's review of these models.[8] Given the use of the default data sets and input values, this is unsurprising. Indeed variance in the results would have been more remarkable.

### *Hatfield Model 5.0*

**Loading the Model**

We installed the model on the hardware platform defined earlier in this report. The system was running the Windows 95 operating system and associated peripherals, but was otherwise "unloaded." The software was installed from a CD-ROM designated Hatfield Model Release 5.0. The CD-ROM was an updated version of the *Preliminary* version of the Hatfield Model Release 5.0 and contained what appeared to be a complete data set. Installation notes were clear, identifying possible program inconsistencies (for example, version incompatibilities) and recommending solutions to problems that might arise.

Software installation required approximately 10 minutes after the display of the introductory splash screen. No unusual conditions were encountered during software loading. The installation required approximately 135 megabytes of free space. The installation process did not automatically load the documentation files (approximately 0.5 megabytes), run results for 12 kilofeet sample cases (approximately 13 mega-

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ber 13, 1997, page 7.

[8] *Analysis of Benchmark Cost Proxy Model 3.0, Hatfield Model, Version 5.0 and Hybrid Cost Proxy Model*, Christensen Associates, January 14, 1998.

bytes) or run results for 18 kilofeet sample cases (approximately 124 megabytes).

## Model Operation and Manipulation

The user interface is flawed and ineffectual. The order of actions to be completed by the user (that is, the model's workflow) is by no means intuitive. There are no help screens or balloons to assist the user in this area. As a specific example of this problem, we note that the method by which one selects multiple companies for analysis within a given state is rather convoluted. After almost two years of development, one might expect the developers to have incorporated greater sophistication in the workflow and to have provided at least generic help screens.

The first state we examined with the Hatfield Model Version 5.0 was Florida and the first company we attempted to analyze was GTE Florida. This generated an error (error number 3022) with the following description: "The changes you requested were not successful because they would create duplicate values in the index, primary key or relationship. Change the data in the field or fields that contain duplicate data, remove the index, or redefine the index to permit duplicate entries and try again." This was followed by a second error message "Unable to create scenario" and a third, run-time error (error number 3246) "Operation not supported," which in turn caused a spontaneous and undocumented exit from the procedure and program. Assuming this might be a company-specific problem, we elected to analyze data for another telephone company.

The second company we attempted to analyze was BellSouth in Florida. Our first attempt to run the model was initially successful. The model processed the feeder and distribution components, but appeared to "lock-up" when 33% complete in its calculations of switching costs. Subsequently, we identified this "locking" as an idiosyncrasy of the system during operation. In fact, the message bar merely ceases to indicate progress in the on-going processing. We had mistaken the slow performance of the model for complete inactivity.

We re-attempted our analysis of BellSouth. On the second attempt, the system declared an error (error number 3043 -- "Disk or network error") and exited. The third attempt, which consumed one hour and eleven minutes in processing, was successful.

We then re-attempted our analysis of GTE Florida. However, the system repeated its error messages and exited prematurely. To ensure conformance with the designers' implicit expectations, we reloaded the Microsoft Office 97 Professional Edition with SR-1 patches and reactivated all Microsoft Excel Add-ins. We also performed a complete installation of Microsoft Visual Basic 5.0 Professional Edition to ensure the presence of all the standard (that is, Microsoft-supplied) Visual Basic add-ons, plug-ins and components. We then tried to analyze the GTE Florida data set a third time, but were again unsuccessful.

We then analyzed United Telephone of Florida. Processing required 21 minutes and proceeded without difficulty. At this point, we turned our attention to the analysis of groups of companies within the sample states.

## Results of Model Analysis

The Hatfield Model Release 5.0 designers included a file named Problem Clusters.XLS that lists known problems with input data. The designers identified 584 erroneous clusters of information in that workbook. Within this file, we identified four problem clusters within GTE Florida. However, we also identified four problem clusters within BellSouth in Florida and three problem clusters within United Telephone of Florida, both of which companies we processed without difficulty. Our tentative conclusion is that the GTE Florida data set contains otherwise unidentified problems. Given our sample, it is unclear how widespread this type of problem is within the data set.

Interestingly, this problem did not persist. After spot-checking individual companies, we reprocessed the complete data set for all companies within the state of Florida. We selected the multi-company option and then selected all Florida companies. We do not offer an explanation for this anomaly, which may be the result of the interaction of scenarios with available data or may reflect some underlying yet unidentified problem.

The results of the analysis were consistent with expectations based on a review of the input data. As in past versions, the model generates superficially plausible networks that probably could not be built, even in a scorched-node scenario, due to the extraordinarily high expectations regarding structure sharing. Moreover, the minimal nature of the networks argues strongly that they would not be capable of supporting advanced services, in contravention of the FCC specification that loop design "should not impede the provision of advanced services."[9]

As noted, the results of our aggregated analysis agreed with those of Christensen Associates.[10] We do observe that noticeable improvement has been made in the calculation of distances in the latest iteration of the model. Furthermore, we tentatively concur with the analysis of Kennett that the model would outperform the HCPM

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[9] Federal-State Joint Board on Universal Service (Joint Board), CC Docket 96-45, *Report and Order FCC 97-157*, released May 8, 1997, paragraph 250, cited in Public Notice, *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, DA 97-2372, Released November 13, 1997, page 5.

[10] *Analysis of Benchmark Cost Proxy Model 3.0, Hatfield Model, Version 5.0 and Hybrid Cost Proxy Model*, Christensen Associates, January 14, 1998.

2.0 if complete, verified geo-coded data were available.[11] Unfortunately, we do not yet have such data for our analysis, a point to which we return in our conclusion.

### *Benchmark Cost Proxy Model 3.0*

#### Loading the Model

We installed the model on the hardware platform defined earlier in this report. The system was running the Windows 95 operating system and associated peripherals, but was otherwise unloaded. The software was installed from a CD-ROM designated BCPM Version 3, Lot 3A-52 52 State.

Software installation required 4 hours and 17 minutes after the display of the introductory splash screen. No unusual conditions were encountered during software loading. The installation required more than 600 megabytes of free space, a fact that we consider sufficiently exceptional that it should be noted on the CD-ROM or in a second splash screen to prevent "space availability" problems during installation.

This exceptional space requirement is the result of the inclusion of calculation results for all 50 states, the District of Columbia and Puerto Rico. Due to the space requirements of a complete installation, we recommend that the BCPM developers make possible a partial installation of the software. Given the ultimate intended application of the model, the simplest way to implement this recommendation would be to permit installation by state.

To test for the possible existence of problems in the installation procedure per se, we removed the software from the test machine, copied the installation file to the

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[11] Correspondence: D. Mark Kennett to Magalie Roman Salas, Subject: "Geographic Data and Forward-Looking Cost Modelling, Dockets 96-45 and 97-160," December 23, 1997, page 2.

hard disk and reinstalled the software. The installation proceeded much more rapidly, requiring approximately fifteen minutes. Nevertheless, we still recommend the option of a partial installation of software.

## Model Operation and Manipulation

Initial testing was marred by several deficiencies. Attempts to use the screen displayed after pressing the "Inputs" button on the main "Controls" screen generated the message: "Missing Reference to the following library: Microsoft Visual Basic for Applications Extensibility." Attempts to use the screen displayed after pressing the "Review" button on the Main "Controls" screen generated the message: "Error Microsoft Visual Basic Run-time Error "94" Invalid use of Null." In the latter case, pressing the debug button that appears indicates that the problem is associated with the statement "ViewName=Cstr(lbxStates)" in the Properties section of sheet 11. In both cases, processing, and therefore testing, ended with these errors.

As with the Hatfield Model, the designers of the BCPM have made some significant assumptions about the nature of the software available to support the model. We reloaded the Microsoft Office 97 Professional Edition with SR-1 patches and reactivated all Microsoft Excel Add-ins. We also performed a complete installation of Microsoft Visual Basic 5.0 Professional Edition to ensure the presence of all the standard (that is, Microsoft-supplied) Visual Basic add-ons, plug-ins and components. After this reinstallation, we reinstalled the BCPM and began renewed testing.

The model operates as specified in the system documentation. The user interface serves reasonably well, although there are numerous opportunities for misinterpretation due to the slow performance of the model. That is, although the software sets the cursor focus when a window is opened, the slow display of items such as the list of states or list of all companies can mislead the user into making premature and incorrect decisions regarding subsequent steps. This problem can be corrected in subsequent versions by limiting the amount of data loaded before analysis or by optimizing the process.

Report generation required an inordinate amount of time (more than five hours using a typical laser printer). Moreover, substantial resources were wasted during printing by the lack of advice regarding print formatting. Pages 2 and 4 of each company report were blank except for page footers. We encourage the developers to exercise some effort to mitigate this problem in future releases.

## Results of Model Analysis

Once again, the results of our aggregated analysis agreed with those of Christensen Associates.[12] We do note that the model has some difficulty with multi-state companies, such as Quincy Telephone and Southern Bell Telephone. For both companies, a single report was generated even though the companies have services areas in both Florida and Georgia. This may be a function of the aggregation of data or an artifact of the testing *per se*.

As was the case with the Hatfield Model, the BCPM 3.0 produces results commensurate with the input values. The developers acknowledge that little has changed in their user inputs since the release of version 1.1.[13] The key areas of improvement appear to reside in the refined estimation of distances to customers and in the development of a more robust user interface. As with HM 5.0, however, the user interface workflow remains far from intuitive. The model provides little internal help.

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[12] *Analysis of Benchmark Cost Proxy Model 3.0, Hatfield Model, Version 5.0 and Hybrid Cost Proxy Model*, Christensen Associates, January 14, 1998.

[13] *Submission of the BCPM3 Model by BellSouth Corporation, BellSouth Telecommunications, Inc., US West, Inc., and Sprint Local Telephone Companies*, December 11, 1997, "National Results Preface," page 1.

### *Hybrid Cost Proxy Model 2.0*

NOTE: On December 3, 1997, we submitted a full and formal critique of the Hybrid Cost Proxy Model modules that had been released for public comment.[14] The date stamps on several files in the December 17, 1997 release of the Hybrid Cost Proxy Model designated HCPM 2.0 indicate that virtually all the input values were identical to those reviewed in the December 3 submittal. Moreover, given that the date stamps on several of the output files are as early as December 10, it is unlikely that the modules themselves have been changed substantially. Therefore, we refer readers to our comments in that report.

#### Loading the Model

The HCPM developers did not provide a setup or installation program, presumably because the HCPM remains primarily a collection of modules and data, as opposed to a fully functional model. Thus, "loading" the model consists of copying files from the CD-ROM to a hard disk drive. However, because the sponsors provided a complete data set, the modules could be manipulated from the CD-ROM without installation on a hard disk drive.

#### Model Operation and Manipulation

Because the HCPM remains primarily a collection of modules and data, as opposed to a fully functional model, there is no user interface nor is there a work environment to test. Two modules, CENBLOCK.exe and FEEDDIST.exe are provided. The CENBLOCK software model is used to define hypothetical serving areas and to cal-

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[14] Robert F. Austin, Ph.D. *Comment on the Hybrid Cost Proxy Model for Determining Universal Service Support for Non-Rural Carriers: The CENBLOCK and FEEDDIST Software Modules, Ex Parte* Filing, Federal Communications Commission Docket Nos. 96-45 and 97-160, December 3, 1997.

culate distances between central offices and the population centroid of those hypothetical serving areas. The FEEDDIST software module is designed to estimate the investment necessary to provide narrowband telephone services within specified areas. This is done by processing the results of the CENBLOCK software module distance calculations using algorithms detailed by the authors in their definitive paper.[15]

The developers have provided a batch file for operation in a Windows NT environment. The developers state that calculation of values for the entire United States can be completed in 24 hours through the use of this batch file. Given our use of the hardware and software configuration described earlier, we could not test this assertion.

**Results of Model Analysis**

The HCPM does not include modules for the calculation of certain key inputs. Specifically, although the module does estimate loop costs, there are no modules in place to estimate transport costs, switching costs, signaling costs or expense costs.[16] Consequently, it is not possible to evaluate the model in the same terms of reference as the other models submitted for review. Specifically, the key Joint Board criteria for evaluation cannot be satisfied because the model does not provide complete output.[17]

In our opinion, the developers have given insufficient attention to the definition of

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[15] Bush, Kennet, Prisbrey, Sharkey and Gupta, 1997, especially section 4, pages 6-13.

[16] Correspondence: William W. Sharkey and D. Mark Kennett to Magalie Roman Salas, "Subject: Additional Information Pertaining to the December 11, 1997 Release of the Hybrid Cost proxy Model," December 23, 1997, section IV, paragraph 1, page 2.

[17] Federal Communications Commission Public Notice, *Guidance to Proponents of Cost Models in Universal Service Proceeding: Customer Location and Outside Plant*, DA 97-2372, Released Novem-

output reports. The current reports are somewhat cumbersome physically and contain simple spelling errors such as "girdsize." We infer that this is a function of the comparative youth of the model.

We acknowledge the success that the FCC staff has enjoyed to date in merging selected features of early versions of the Hatfield Model and the BCPM and we encourage the continued development of the hybrid model, complete with all required modules.

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ber 13, 1997, see pages 7-8 for a list of these criteria.

## Discussion

### *General*

During this period of model definition and refinement, there has been some noticeable convergence of the algorithms and structures of the Hatfield Model and the BCPM, but little convergence of the user interfaces. The operation of the models has stabilized significantly, although performance has suffered dramatically as each model has incorporated additional procedures, interfaces, reports and data for the sake of thoroughness. The models still reveal their divergent underlying assumptions in the results generated by users, although the gaps in results are smaller than in the past.

Brought into stark relief in part by the convergence of the algorithms, the fundamental problem of data input remains a matter of serious concern. The specification of input parameters is a major issue that must be addressed during the months ahead as model building proceeds. We believe that four key areas of concern can be identified:

- Methods of defining locations
- Structure sharing
- Input prices and related input values
- Loop engineering assumptions

NOTE: As we observed in our discussion of the Hybrid Cost Proxy Model, we do not consider this prototype model sufficiently well developed to permit detailed comparative analysis at this time. Our comments on the Hybrid Cost Proxy Model are somewhat limited as a result. We do recognize that the direction of development may lead to the completion of this model, at which time more detailed comparisons could be made.

## *Methods of Defining Locations*

### The Distance Metric

One critical issue in the development and use of cost proxy models is the calculation of the length of the transmission loops to be designed. The distance sensitivity of various transmission technologies is the impetus for constructing a module or mechanism to estimate the distance from the central office to the customer base. Almost without exception, this distance should be calculated within the framework of a non-Euclidean, rectilinear geometry (specifically, a Riemannian geometry or so-called "Manhattan Metric"). Distance "as the crow flies" - a Euclidean distance metric -- is unacceptable for the present purposes (except, of course, when by coincidence the rectilinear distance happens to equal the Euclidean distance.) *Ceteris paribus*, the more accurately a model can incorporate distance parameters, the more accurately -- at least theoretically -- it can model the cost of providing services.

In our opinion, Kennett has summarized the issues related to distance calculations succinctly and, with one significant exception, quite accurately.[18] This exception is his conclusion regarding which model would offer the most accurate methodology ***if*** geo-coded data were available for the analysis. We do not believe that such speculation is justified or warranted. However, it does serve to focus attention on the fundamental requirement for more accurate location information. Knowing the length of the loops to be built is a fundamental necessity of the modeling process.

### Geo-Coding

As Kennett points out, the various methods used to date to estimate the actual length of the loops to be built fall short because the models do not include accurate

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[18] Correspondence: D. Mark Kennett to Magalie Roman Salas, Subject: "Geographic Data and Forward-Looking Cost Modelling, Dockets 96-45 and 97-160," December 23, 1997.

measurements of where current customers are ***actually*** located. This problem of using estimated locations is brought into focus by the failure of the Hatfield Model Release 5.0 to address the fundamental necessity of providing service to all citizens that request service. The model's rather naïve assumption that only current subscribers should be considered in the analysis is presumptuous in the extreme.[19] The local telephone company must provide telephone service if a customer requests telephone service, regardless of the impact on the subsidy pool for long distance carriers. Consequently, the model must consider the location of all households, whether or not served at present.

We take exception to the assertion that the Hatfield Model 5.0 uses geo-coded data. The model uses estimated locations of clusters of customers, presented in the format of geo-coded data sets, as opposed to actual locations of customers. Although the model could use specific geo-coded customer addresses, it does not do so in the present version.

The development of the models has been surrounded by on-going argument about the best method of estimating locations. The developers have used numerous commercial data sets, federal government data sets and even satellite imagery to estimate locations, yet no firm agreement has been reached on the accuracy of the data. Arguments about data accuracy, data currency, data completeness, sensitivity to clustering (including, presumably, spatial auto-correlation), data availability for rural areas, PO Box address handling and related issues continue to plague the model building process.

The fundamental importance of distance as a parameter in the cost proxy models is

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[19] Correspondence: Richard N. Clarke to Magalie Roman Salas, Re: Ex Parte Presentation - Proxy Cost Models, December 24, 1997, attachment entitled: "Scorecard Modeling Customer Location: Hatfield 5.0 vs. BCPM3," AT&T and MCI, December 23, 1997, page 2.

no longer a debated issue. The only clear, unambiguous and unequivocally accurate way to confirm customer locations would be to geo-code these addresses and to make the data set available to the model builders. Although geo-coding is an admittedly time-consuming and expensive procedure, such technological innovations as mobile GPS data collection could expedite the process and reduce the cost of acquiring and incorporating this information.[20] The money currently spent on the ongoing debate could be dedicated to building a data set about which there would be no debate. In any event, the costs of acquiring a true, geo-coded data set could be recovered from, or reallocated to, secondary uses such as E911 services and real-time SCADA systems linked to other telephone company services. There certainly is no reason to expend additional resources on the development and maintenance of yet another proprietary database to support estimates, as proposed by the sponsors of the Hatfield Model 5.0, when actual locations can be recorded.[21]

### *Structure Sharing*

NOTE: The discussion in this section appeared originally in our report on the Hatfield Model Version 2.2, Release 2.[22] Because of their persistent applicability, the comments were excerpted and reprinted in our report on the Hatfield Model Version 3.0/3.1.[23] To a great extent, the observations continue to be relevant not only *vis-à-vis* the Hatfield Model, but also for the complete model building process.

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[20] See, for example, the GPSVision™ system and methodology developed by Lambda Tech International of Waukesha, Wisconsin or the similar system built by Transmap of Columbus, Ohio.

[21] Correspondence: Richard N. Clarke to Magalie Roman Salas, Re: Ex Parte Presentation - Proxy Cost Models, December 11, 1997, attachment entitled: "PNR Estimates of the Resources Required to Support the Customer Location Model."

[22] Robert F. Austin, Ph.D. *Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model 2.2, Release 2, Ex Parte* Filing, Federal Communications Commission Docket No. 96-45, February 5, 1997, pages 7-15.

[23] Robert F. Austin, Ph.D. *Engineering Evaluation of Cost Proxy Models for Determining Universal Service Support: Hatfield Model 3.0/3.1, Ex Parte* Filing, Federal Communications Commission Docket No. 96-45, March 17, 1997, pages 5-11.

## Introduction

*The Federal-State Joint Board on Universal Service, CC Docket 96-45 ("Joint Board") published its* Recommended Decision *on November 8, 1996. In that document, the Joint Board specified that the "technology assumed in the model should be the least-cost, most efficient and reasonable technology for providing the supported services that is currently available for purchase."*[24] *Furthermore, the Joint Board specified that: "All underlying data should be verifiable, engineering assumptions reasonable, and outputs plausible."*

*While these specifications arguably may be in conflict in some instances, they certainly constitute an endorsement for sharing network construction costs among several companies where feasible. Both models address the subject of structure sharing explicitly in several tables and implicitly in their structure. In brief, the concept assumes that several companies could use some or all support structures in a telephone network simultaneously. For example, in theory several companies could attach aerial cables to a pole.*

*The number of companies that may attach facilities to a pole depends primarily on the height of the pole, the class of the pole, and the number of pre-existing attachments. The height of the pole is a factor because federal, state, and local laws and ordinances, as well as safety concerns mandate certain minimum clearances over roadways and railroad tracks below the cable spans. These and other parameters, such as the weight of the cable, dictate the minimum height at which users may attach cables to poles.*

*The same and other regulations prescribe the spacing of cables on a pole. In combination, these constraints determine the maximum theoretical number of cables that users may attach. Similarly, the class of the pole, which corresponds to the diameter of the pole (six feet above ground after pole placement), determines the total load that the pole may bear and the support guying required. Pre-existing attachments, by definition, occupy space to the exclusion of newcomers.*

*... We note first that a high assumed rate of structure sharing would result in a calculated reduction of the average forward-looking costs of construction, hence a reduced cost for unbundled network elements. This would*

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[24] Federal-State Joint Board on Universal Service, CC Docket 96-45, *Recommended Decision*, November 8, 1996, ("Joint Board Decision"), paragraph 277.

*result in lower network "assembly" or "element leasing" costs (as opposed to construction costs) for the sponsors. In other words, the higher the rate of sharing that the model assumes, the lower the pro rata cost of new network construction that the model will calculate.*

*Second, a higher rate of proposed structure sharing infers the existence and current availability of a larger amount of structures for immediate use in network build-out by entrants to the market. If Entrant Local Exchange Companies ("ELEC") should decide to reject the pricing of unbundled network elements, they could demand access to this hypothetical structure capacity. If the Incumbent Local Exchange Companies ("ILEC") do not make capacity available, the ELECs could claim that the ILECs were intentionally and anti-competitively withholding this hypothetical capacity...*

*Third, the structure sharing rates presented in the model imply that the ILECs have been prodigiously inefficient and profligate in their spending by failing to share structures at the rates recommended by the Hatfield Model sponsors. While this may be a comforting, albeit self-serving, assumption, it also, in most respects, is an unreasonable assumption. During the first 80 years of the life of the telephone industry, there were no CATV companies to share structures. Therefore, the telephone companies did not build structures to share with them.*

*During the same 80 years, there were no dielectric, fiber optic cable transmission facilities that could safely share a duct or feeder route trenches with power cables. The ILECs shared poles where it was possible, given concerns about induction coordination, by attaching telephone cables to power poles, by organizing joint construction in appropriate areas, and by installing larger poles, under certain circumstances, and leasing capacity to the power companies.*

## Incorporating Structure Sharing in a Model

*The Joint Board's specifications regarding universal service costs are clear and unequivocal. Only forward-looking costs may be considered. The scenario they specify dictates that, for modeling purposes, there are no existing telephone network structures or facilities. The scenario also specifies that models should assume that the locations of the existing wire centers persist. (Although with the benefit of 100 years of hindsight some observers may judge these wire center locations to be less than optimal, their selection for modeling is a neutral assumption: all models will work from the same given location to build new networks. In any event, their locations reflect the distribution of population reasonably well.)*